THE EFFECTS OF FUELS REDUCTION TREATMENTS ON SOUTHWESTERN DWARF MISTLETOE IN PONDEROSA PINE IN THE WILDLAND URBAN INTERFACE

Final Report

Study RMRS-99078-RJVA

The Effects of Fuels Reduction Treatments on Southwestern Dwarf Mistletoe in Ponderosa Pine in the Wildland-Urban Interface

Prepared by Dr. Robert L. Mathiasen
School of Forestry
Northern Arizona University
Flagstaff, Arizona
April 15, 2002

Introduction

Southwestern dwarf mistletoe (*Arceuthobium vaginatum* ssp. *cryptopodum* [Engelm.] Hawksw. & Wiens) is a common parasite of ponderosa pine (*Pinus ponderosa* Laws.) in the Southwest (Hawksworth 1961, Hawksworth and Wiens 1996). Surveys conducted in the late 1950's in Arizona and New Mexico estimated that approximately 36 percent of the ponderosa pine commercial forests or 2.5 million acres were infested by Southwestern dwarf mistletoe (Andrews and Daniels 1960). More recent surveys, which tried to duplicate the late 1950's surveys, estimated that about 32 percent of the ponderosa pine type on the Coconino National Forest were infested by this mistletoe (Hessburg and Beatty 1985). Because of the widespread occurrence of dwarf mistletoe in Southwestern ponderosa pine forests, the severity of the infestations, and the detrimental effects this parasitic flowering plant has on its hosts, resource managers have attempted to "control" Southwestern dwarf mistletoe for many years. However, attempts to either eliminate this parasitic plant or to at least reduce the detrimental effects it has on ponderosa pine (increased mortality and reduced growth) have generally been unsuccessful (Dahms and Geils 1997). Because of past management practices (high grading, partial cutting and fire suppression) in dwarf mistletoe-infested pine in the Southwest, the severity of dwarf mistletoe infestations have probably increased in the last 30 years (Maffei and Beatty 1988, Dahms and Geils 1997).

Little is currently known about the effects that severe dwarf mistletoe infestations in pine forests have on fuels creation or fire behavior (Alexander and Hawksworth 1975). Although fire is considered to be the natural control agent of dwarf mistletoe (Roth 1953, Hawksworth 1961, Alexander and Hawksworth 1975), little information is available on the effects of fire on dwarf mistletoe populations, particularly for ponderosa pine. Only a few studies have examined the effects of fire in ponderosa pine forests and only one of these was conducted in the Southwest. Koonce and Roth (1985) studied the survival of ponderosa pine in areas infested with Western dwarf mistletoe (*Arceuthobium campylopodum* Engelm.) and treated with prescribed fire in Oregon. Their study was conducted in immature, even-aged pine stands. They concluded that dwarf mistletoe could be sanitized from thinned and unthinned ponderosa pine stands using

prescribed burning. Harrington and Hawksworth (1988) reported that the degree of dwarf mistletoe infection positively influenced the degree of crown scorch in ponderosa pine within a prescribed burn on the South Rim, Grand Canyon National Park, Arizona. They also noted that trees with moderate amounts of scorching were more likely to die as their degree of mistletoe infection increased.

Several effects of dwarf mistletoe parasitism in pine forests, such as increased mortality, stunted and deformed trees, spike tops, witches' brooms and resin-soaked branches and stem infections, tend to increase the fire hazard and fire behavior (fire intensity, rate of spread, crowning, and duration) of dwarf mistletoe-infested forests (Alexander and Hawksworth 1975). Therefore, efforts to reduce fire hazard and modify fire behavior in ponderosa pine forests must consider the degree of dwarf mistletoe infestation in these forests if these efforts are to be successful. Furthermore, we know little about the effects of fuel reduction treatments on dwarf mistletoe populations in ponderosa pine forests of the Southwest. Likewise, we know little about the effects of residual dwarf mistletoe populations on fuel loading following fuel reduction treatments.

Work Completed

The study area for this project is located in the wildland/urban interface near Flagstaff, Arizona in the northwest corner of what is referred to as the Fort Valley 10K Unit. The study area consists of approximately 200 acres in Township 22 North, Range 6 East, Section 13 and Township 22 North, Range 7 East, Section 18 (Figure 1). The area is surrounded by the Snow Bowl Road as the west boundary; the El Paso Natural Gas Pipeline as the south boundary; the Freidlein Prairie Road (Forest Road 522) as the north boundary; and a north-south running eastern boundary line approximately 42 chains (845 m) east of the Snow Bowl Road. The study area is composed of almost pure ponderosa pine stands with varying degrees of dwarf mistletoe infection ranging from light to severe. The dwarf mistletoe infestations range in size from approximately 0.25 ha to well over 3 ha. Occasional Douglas-fir (*Pseudostuga menziesii* (Mirb.) Franco), limber pine (*Pinus flexilis* James), Gambel oak (*Quercus gambelii* Nutt.), and aspen (*Populus tremuloides* Michx.) are intermixed in the study area.

The study area was subdivided into six treatment blocks, each approximately 30-45 acres [12-18 ha] in size (Figures 1 and 2). These blocks will receive the following fuel reduction treatments: Block 19) a control with no treatments; Block 18) a burn only treatment where only a prescribed burn will be used to reduce fuel loads; Block 22) a ponderosa pine ecosystem restoration treatment using a 1.5/3 prescription followed by a prescribed burn; Block 21) a uneven-aged harvest followed by a prescribed burn; Block 20) a thinning from below following the recommendations of the Southwest Forest Alliance followed by a prescribed burn; and Block 17) a dwarf mistletoe reduction treatment designed to reduce the level of dwarf mistletoe by thinning from below and above and followed by a prescribed burn. In each treatment block, three one-hectare (100 m x 100 m) monitoring plots have been installed to monitor the effects of the six different treatments on dwarf mistletoe populations, tree survival, and fuel loading immediately after the treatments. These plots are to be monitored for several years following the initial

treatments and any subsequent fuel reduction treatments that follow if additional funding becomes available.

Monitoring Plot Establishment

In each of the six treatment blocks, three monitoring plots (100 m x 100 m; one-hectare) have been located and all tree data has been collected. A summary of the stand conditions for living ponderosa pines for all 18 of the one-hectare monitoring plots is presented in Appendix A.

In each block that will have thinning/harvesting conducted, all "leave-trees" have been marked with orange paint. All "leave-trees" have been tagged with pre-numbered metal tags and pertinent data (described below) has been collected for each residual tree. Monitoring plots were established within severely infested areas of each treatment block whenever possible.

Monitoring plots have been documented so these permanent plots can be easily relocated and re-measured when necessary. Each plot was established using a staff compass and surveying flags to mark boundaries. Trees just outside of each plot boundary were marked with a yellow dot facing plot center after treatments are completed. Plot corners and centers were marked with green T- posts, rock cairns and a yellow band around the closest residual tree. The location of each monitoring plot was also described in detail on a Plot Cover Page (Appendix B). Plots can be relocated using a reference point along a major access road. The distance and azimuth from the reference point to the center of the plot being documented was also recorded on Plot Cover Pages. When necessary, supplemental reference points were used to relocate plot centers.

The site index for ponderosa pine (Minor 1964) of each treatment block was estimated using from 5-10 dominant ponderosa pine growing in the monitoring plots or within two chains (40 m) of their boundaries. Site trees were selected using the criteria listed in Minor (1964). No site trees with a dwarf mistletoe rating (Hawksworth 1977) greater than 2 were used and whenever possible selected site trees had no dwarf mistletoe infection. The age at breast height and total height (nearest one-foot [0.3 m]) of selected site trees was recorded on Plot Cover Pages

In addition to recording directions to monitoring plot centers, the azimuth of plot boundaries, the number of residual trees tagged, the treatment block number and plot number were recorded on Plot Cover Pages. A sketch map showing the approximate location of the plot, reference point, and supplemental reference point (if used), access roads and other pertinent information for relocating each plot was completed on Plot Cover Pages also.

Residual Tree Measurements

Each residual tree within a selected monitoring plot was tagged with a pre-numbered metal tag at breast height (1.37 m above the ground on the uphill side of the tree). Metal tags are visible from the preceding tree (in numerical sequence) in monitoring plots more than 4 chains (80 m) from major access roads. In plots within 4 chains of major access roads, metal tags were placed a breast height facing away from the road. It is hoped this procedure will make the monitoring plots much less visible from access roads, particularly the Snow Bowl and Freidlein Prairie

Roads. Residual trees less than one inch in diameter were tagged at their base. Only live and dead trees greater than 4.5 feet [1.37 m] in height were tagged. No regeneration data was collected. Dead trees with little or no bark left on them were not be tagged unless they were over 20 feet [6 m] in height.

The following data was recorded for each tagged live tree in each monitoring plot:

1. Plot Number
2. Tree Number
3. Species Code (1 – Ponderosa Pine; 2 – Douglas-fir; 3 – Limber pine; 4 – Alligator juniper; 5 – Pinyon pine; 6 – Utah juniper; 7 – Aspen; 8 – Other)
4. Diameter at Breast Height (nearest 0.1 inch [0.254 cm])
5. Crown Class Code (0 – Dead; 1 – Dominant; 2 – Codominant; 3 – Intermediate; 4 – Suppressed)
6. Height to the lowest point on the lowest dwarf mistletoe broom less than 6 m in height (recorded to the nearest 0.5 ft. (0.15 m))
7. Condition of the lowest broom (0 – Dead; 1 – Living)
8. Dwarf Mistletoe Rating (DMR, 6-class system) of the bottom third of the live crown
9. Dwarf Mistletoe Rating of the middle third of the live crown
10. Dwarf Mistletoe Rating of the top third of the live crown
11. Total Dwarf Mistletoe Rating (DMR, 6-class system) (Sum of Numbers 8-10 above)
12. Witches' Broom Rating for the bottom third of the tree (0 – No brooms present; 1 – 1-30 percent of the third is broomed; 2 – 31-60 percent of the third is broomed; and 3 - > 60 percent of the third is broomed. This rating uses the total height of the tree and not just the live crown of the tree)
13. Witches' Broom Rating for the middle third of the tree
14. Witches' Broom Rating for the top third of the tree

Data recorded for tagged dead trees only included numbers 1-5 above.

The following data was recorded for each live tree not tagged in each monitoring plot:

1. Plot Number
2. Tree Number
3. Species Code (1 – Ponderosa Pine; 2 – Douglas-fir; 3 – Limber pine; 4 – Alligator juniper; 5 – Pinyon pine; 6 – Utah juniper; 7 – Aspen; 8 – Other)
4. Diameter at Breast Height (nearest 0.1 inch [0.254 cm])
5. Total Dwarf Mistletoe Rating (DMR, 6-class system)

A sample of two trees per one-inch diameter class was measured for total height (nearest one-foot [0.3 m]) and height-to-live crown (nearest one-foot [0.3 m]). Trees to be measured for height were selected using a tally form and were selected attempting to sample trees from throughout the plot.

Fuel loads (downed woody material) were estimated for each monitoring plot using the fuels inventory procedure described by Brown (1971). In each monitoring plot eight sample points were randomly selected. Sample points were determined by randomly choosing a compass azimuth. Two sample points were established at one-chain (20 m) intervals from the plot center

along this randomly selected bearing. Subsequent sample points were selected by using three additional bearings offset 90 degrees from the original bearing and locating 2 sample points at one-chain (20 m) intervals along each transect line. Therefore, a total of 4 transect lines were run from each plot center with two sample points on each transect line for a total of eight sample points.

At each sample point the procedures outlined in Brown (1971) under Sample Point Procedures (Steps 1-9) were followed. Tally rules 1-9 were used as criteria for selecting and measuring downed woody material in each sampling plane. Slope to the nearest 10 percent was recorded at each sample point. Fuel loads (tons per acre) for each monitoring plot were calculated using the procedures (Steps 1-13) listed in Brown (1971).

Monitoring Plot Re-Measurements

Each monitoring plot will be re-measured with 1-3 months after it has been prescribed burned. Control plots will not be measured until one year after plot establishment. Monitoring plots will be re-measured annually after the initial re-measurement. In treatment blocks that have been burned the following data will be collected (data to be collected may need to be modified) for each tagged tree:

1. Plot Number
2. Tree Number
3. Total Amount of Scorching on Tree (Percent of total height affected by scorching)
4. Scorching at Base (0 – None; 1 – Light; 2- Moderate; 3 – Severe)
5. Scorching in Lower Crown (0 – None; 1 – Light; 2- Moderate; 3 – Severe)
6. Scorching in Middle Crown (0 – None; 1 – Light; 2- Moderate; 3 – Severe)
7. Scorching in Top Crown (0 – None; 1 – Light; 2- Moderate; 3 – Severe)
8. Tree Condition (0 – Dead; 1 – Living)
9. Height to the lowest point on the lowest dwarf mistletoe broom less than 20 feet [6 m] in height (recorded to the nearest 0.5 ft. [0.066 m])
10. Condition of the lowest broom (0 – Dead; 1 – Living)
11. Dwarf Mistletoe Rating (DMR, 6-class system) of the bottom third of the live crown
12. Dwarf Mistletoe Rating of the middle third of the live crown
13. Dwarf Mistletoe Rating of the top third of the live crown
14. Total Dwarf Mistletoe Rating (DMR, 6-class system) (Sum of Numbers 8-10 above)
15. Witches' Broom Rating for the bottom third of the tree (1 – No brooms present; 1 – 1-30 percent of the third is broomed; 2 – 31-60 percent of the third is broomed; and 3 - > 60 percent of the third is broomed. This rating uses the total height of the tree and not just the live crown of the tree)
16. Witches' Broom Rating for the middle third of the tree
17. Witches' Broom Rating for the top third of the tree
18. Estimate of probability that tree will die within one year because of scorching (0 - No probability; 1 – 0.1 to 0.33 probability; 2 – 0.34 to 0.66 probability; 3 > 0.66 probability)
19. Estimate of probability that tree will die within two years because of scorching (0 - No probability; 1 – 0.1 to 0.33 probability; 2 – 0.34 to 0.66 probability; 3 > 0.66 probability)

20. Estimate of probability that tree will die within five years because of scorching (0 - No probability; 1 – 0.1 to 0.33 probability; 2 – 0.34 to 0.66 probability; 3 > 0.66 probability)

Monitoring plots in the control block will have the following data collected (data to be collected may need to be modified) for each tagged tree:

1. Plot Number
2. Tree Number
3. Species Code (1 – Ponderosa Pine; 2 – Douglas-fir; 3 – Limber pine; 4 – Alligator juniper; 5 – Pinyon pine; 6 – Utah juniper; 7 – Aspen; 8 – Other)
4. Diameter at Breast Height (nearest 0.1 inch [0.254 cm])
5. Crown Class Code (0 – Dead; 1 – Dominant; 2 – Codominant; 3 – Intermediate; 4 – Suppressed)
6. Dwarf Mistletoe Rating (DMR, 6-class system) of the bottom third of the live crown
7. Dwarf Mistletoe Rating of the middle third of the live crown
8. Dwarf Mistletoe Rating of the top third of the live crown
9. Total Dwarf Mistletoe Rating (DMR, 6-class system) (Sum of Numbers 8-10 above)
10. Witches' Broom Rating for the bottom third of the tree (1 – No brooms present; 1 – 1-30 percent of the third is broomed; 2 – 31-60 percent of the third is broomed; and 3 - > 60 percent of the third is broomed. This rating uses the total height of the tree and not just the live crown of the tree)
11. Witches' Broom Rating for the middle third of the tree
12. Witches' Broom Rating for the top third of the tree

Data for all re-measurements will be summarized for each monitoring plot and for all plots within each treatment block. Specific data analysis procedures will be developed during phase two of this study.

Treatments Completed

As of April 2002 only one treatment has been completed; the burn only treatment of Block 18 (Figure 2). This block was burned in late August 2001. In September some preliminary post-fire data was collected on tree scorching and tree mortality. The three monitoring plots in Block 18 will be revisited in the late spring 2002 to gather additional information on tree mortality.

Literature Cited

Alexander, M. E., and F. G. Hawksworth. 1975. Wildland fires and dwarf mistletoes: A literature review of ecology and prescribed burning. USDA Forest Service General Technical Report RM-14, 12 p.

Andrews, S. R., and J. P. Daniels. 1960. A survey of dwarfmistletoes in Arizona and New Mexico. USDA Forest Service, Rocky Mountain Research Station, Station Paper No. 49, 17 p.

Brown, J. K. 1971. Handbook for inventorying downed woody material. USDA Forest Service General Technical Report INT-16, 24 p.

Dahms, C. W., and B. W. Geils. Technical Editors. 1997. An assessment of forest ecosystem health in the Southwest. USDA Forest Service General Technical Report RM-GTR-295, 97 p.

Harrington, M. G., and F. G. Hawksworth. 1988. Interactions of fire and dwarf mistletoe on mortality of southwestern ponderosa pine. In Krammes, J. S., Technical Coordinator, Effects of fire management of southwestern natural resources: Proceedings of the symposium. USDA Forest Service General Technical Report RM-191, pp. 234-240.

Hawksworth, F. G. 1961. Dwarfmistletoe of ponderosa pine in the Southwest. USDA Technical Bulletin 1246, Washington, D.C., 112 p.

Hawksworth, F. G. 1977. The 6-class dwarf mistletoe rating system. USDA Forest Service, General Technical Report RM-48, 7 p.

Hawksworth, F. G., and D. Wiens. 1996. Dwarf mistletoes: biology, pathology, and systematics. USDA Forest Service Agricultural Handbook 709, 410 p.

Hessburg, P. F., and J. S. Beatty. 1985. Incidence, severity, and growth losses associated with ponderosa pine dwarf mistletoe on the Coconino National Forest, Arizona. USDA Forest Service, State and Private Forestry, Southwestern Region, Albuquerque, NM, Report R-3 85-12, 31 p.

Koonce, A. L., and L. F. Roth. 1985. The effects of dwarf mistletoe on fuel in precommercial ponderosa pine stands. In: Proceedings of the Eighth Conference on Fire and Forest Meterology. Society of American Foresters, Washington, D.C., pp. 66-72.

Maffei, H., and J. S. Beatty. 1988. Changes in the incidence of dwarf mistletoe over 30 years in the Southwest. In: Proceedings of the Thirty-sixth Annual Western International Forest Disease Work Conference, Park City, UT, September 19-23, 1988, pp. 88-90.

Minor, C. O. 1964. Site index curves for young-growth ponderosa pine in northern Arizona. USDA Forest Service Research Note RM-37, 8 p.

Roth, L. F. 1953. Pine dwarfmistletoe on the Pringle Falls Experimental Forest. USDA Forest Service, Pacific Northwest Research Station, Research Note 91, 3 p.

Appendix A

Summary of Fort Valley 10K monitoring plot data for live ponderosa pines.

Appendix B

Copies of Cover Pages for Monitoring Plots 1-18

Figures

Figure 1. Approximate locations of treatment Blocks 17-22 in the southeast corner of Section 13 and the southwest corner of Section 18 (see text for complete Public Land Survey information).

Figure 2. Map of study area plotted using Geographic Information Systems data collected by USDA Forest Service, Mormon Lake Ranger District, Coconino National Forest, Flagstaff, AZ.